selected size and location to promote uniform flow and contact of said fluid with said catalyst material, at least a portion of each said thin metal plate on a downstream side is removed to provide a gap between adjacent plates to promote lateral flow of said fluid.

20. (Amended) The catalyst bed recited in claim 15 wherein said removed portion of each said plate comprises unremoved portions forming support columns for supporting each said plate on an adjacent said plate.

REMARKS

Status of the Claims

Claims 1-21 were filed in the present application. Each of the claims as filed are rejected. Claims 1-4, 6-11, 13-19 and 21 are rejected under 35 U.S.C. § 103(a) as being allegedly obvious over Hsu et al. ("Hsu") in view of Ashmead et al. ("Ashmead"). Claims 5, 12, and 20 are rejected under 35 U.S.C. § 103(a) as being allegedly obvious over Hsu in view of Ashmead and further in view of Koga et al. ("Koga"). Applicants respond with a combination of amendment and traverse.

Claim 16 is canceled. Claims 15 and 20 are amended. Claim 15 is amended to incorporate elements of claim 16 and claim 1. The element from claim 16 is the recitation that a portion of the plate is removed to provide a gap between adjacent plates to promote lateral flow of the fluid. The element of claim 1 that is inserted is the recitation that the portion of the plate that is removed is on the "downstream side" of the plate.

Claim 20 is amended to correct an obvious typographical error. As filed, claim 20 was dependent upon claim 1. As there are independent claims intervening between claim 1 and claim 20, it is clear that claim 20 was intended to be dependent upon the nearest independent claim, claim 15. Claim 20 is properly indirectly dependent upon claim 15 via its dependence upon claim 16. Claim 16 is canceled, its elements incorporated into claim 15. Therefore, claim 20 is properly dependent upon claim 15.

As each of the amendments set forth above is fully supported by the specification as filed, no new matter is added by either amendment.

The Invention

Applicants claim an axial flow catalyst pack for the catalytic decomposition of monopropellant fuels. The invention includes an array of stacked metal plates having precisely aligned flow passages, which enhancelateral flow across each plate. Each of the plates of the device has a surface of catalytic material. Moreover, each of the plates of the assembly has a portion removed from the downstream side of the plate to promote lateral flow of the liquid between the plates.

The Rejections

Under 35 U.S.C. § 103(a)

Over Hsu in view of Ashmead

Claims 1-4, 6-11, 13-19 and 21 are rejected under 35 U.S.C. § 103(a) as being allegedly obvious over Hsu in view of Ashmead. The Examiner characterizes Hsu as disclosing an apparatus comprising a plurality of thin metal plates in a stacked contiguous relationship. The plates have a surface of catalyst material and flow through holes through which the fluid in the device flows axially. The Examiner acknowledges that Hsu does not teach that the plates are etched.

Ashmead is characterized as disclosing a device of laminae construction in which catalyst plates can have catalyst deposited on the surface or placed in etched reactor channels.

With respect to claims 1, 3, 15, and 16, the Examiner concludes that it would have been obvious to one of skill to provide channels for catalyst in the plates of Hsu as it is merely the selection of functionally equivalent means of placing catalyst on a thin metal plate.

With respect to claims 2, 9, and 17, the Examiner concludes that the "flow adjustment element" of Hsu reads on Applicants recited metering plate, which is

optionally positioned between two or more plates to provide uniformity of flow through the apparatus.

With respect to claims 3, 10, 18, and 21, the Examiner concludes that Hsu recognizes that the flow adjustment element can be of any suitable design, recognizing that the design of the flow adjustment element is a result effective variable. Thus, it is reasoned that one of skill would have found it obvious to determine the optimum design or designs.

With respect to claims 4, 11, and 19, the Examiner states that Hsu discloses lateral flow of fuel through and between the holes. The Examiner acknowledges that Hsu does not teach that the holes are axially offset. The Examiner relies on Ashmead for a teaching of holes that are axially offset from plate to plate, reasoning that it would have been obvious to one of ordinary skill to offset the flow holes as a matter of engineering choice.

Applicants respectfully submit that, for the reasons set forth below, a prima facie case of obviousness has not been set forth.

A. A Proper Prima Facie Case of Obviousness Has Not Been Set Forth

To construct a *prima facie* case of obviousness, the Examiner must meet three criteria. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references) must teach or suggest all of the claim limitations. *See*, MPEP §2142. Moreover, to avoid the pitfall of hindsight, the Examiner must "identify ***specifically***...the reasons one of ordinary skill in the art would have been motivated to select the references and combine them," *In re Rouffet* 47 USPQ2d 1453, 1459 (Fed. Cir. 1998).

Applicants respectfully submit that each of the required criteria set forth above have not been satisfied, thus, a *prima facie* case of obviousness has not been set forth. First, the combination of the references is deficient, failing to disclose or suggest

every element of the Applicants' claimed invention. Furthermore, the proposed modification to Hsu would destroy the principle of operation and function of Hsu. Therefore, there can be no motivation to make the proposed modification. Finally, in view of Hsu's disparaging devices composed solely of catalyst plates, one of skill would have had no reasonable expectation of success in undertaking the assembly of Applicants' claimed device.

1. Each Element of the Claims is not Found in the Cited References

Independent claims 1, 8, and 15 each recite that the device comprises a set of distinct elements:

(1) a plurality of thin metal plates stacked in a ***contiguous*** relation;

(2) ***each*** plate has a surface of catalytic material;

(3) a portion of the "***downstream*** side" of "***each*** such plate" is "etched" or otherwise "removed to permit lateral flow between the plates;" and

(4) each plate includes a plurality of flow through holes for flow of the fuel "axially through" the stacked plates.

Neither Hsu nor Ashmead, alone or in combination, disclose a device having each of the above recited elements of Applicants' claimed apparatus.

The Examiner states that Hsu discloses an apparatus comprising a plurality of thin metal plates in "a stacked contiguous relation...each having a surface of catalyst material. Applicants respectfully disagree with the Examiner's characterization of Hsu.

Hsu discloses a device in which "a number of thermally conductive plates **12** and reforming plates **14** are ***alternately*** stacked together to form a stacked reforming structure..." *See*, column 4, lines 21-24. The reforming plates include a catalyst (column 4, lines 64-64), which is ***not present*** on the conductive plates. Thus, the Hsu device is a stack of alternating catalytic reformer plates and non-catalytic conducting plates. Therefore, Hsu neither discloses nor suggests Applicants' device in which a plurality of catalytic plates are arranged in a contiguous manner.

Moreover, Hsu does not disclose a device in which each contiguous plate in a plurality of plates is etched, or otherwise patterned, on its downstream surface. For example, with reference to FIG. 2A, Hsu discloses that the "conductive plate **12** is embossed to form reactant flow channels." *See*, column 5, lines 66-67. Hsu does not, however, disclose or suggest that the reforming plates are similarly embossed. As an unembossed reforming plate is inserted between each pair of embossed conductive plates, Hsu cannot be said to suggest an assembly of contiguous plates in which "at least a portion of ***each*** such plate" is etched (or otherwise patterned), as is claimed by the Applicants.

Ashmead is relied upon by the Examiner to supply the disclosure missing from Hsu-that the plates are etched. Similar to Hsu, however, Ashmead does not disclose or suggest a device that includes a plurality of catalytic plates that are arranged contiguously. Ashmead discloses a device in which one pair of plates out of a population of plates is fabricated as a catalytic reactor (**90**). The catalytic reactor is selected from a photochemical reactor, an electrochemical reactor and a reactor that includes a "catalytic material." The remainder of the plates are configured to accomplish an array of functions, e.g., heat fluids (**36**), distribute fluids (**40**), collect fluids (**50**), mix fluids (**62**), act as a heat exchanger (**86**), act as a thermal barrier (**70**), act as a spiral separator (**78**). Ashmead does not disclose or suggest a device in which a plurality of plates performing an identical function are arranged contiguously.

In view of the above, the combination of Hsu and Ashmead cannot be said to disclose or suggest a plurality of catalytic plates etched on their downstream surfaces, which are arranged contiguously. As the combination of references does not disclose or suggest every claimed element of Applicants' claimed invention, a proper *prima facie* case of obviousness cannot be set forth over the cited references. Therefore, Applicants respectfully request the withdrawal of the rejection under 35 U.S.C. § 103 of claims 1-4, 6-11, 13-19 and 21.

With regard to claims 2, 9 and 17, the Examiner states that Hsu discloses a flow adjustment element (80), which reads on Applicants' metering plate. The Examiner

states that the flow adjustment element is placed between groups of thin metal plates to provide uniformity of flow through the apparatus.

The flow adjustment element of Hsu is "interposed between the electrolyte plate **50** and the interconnector plate **60**." *See*, column 10, lines 13-15. Thus, the flow adjustment element of Hsu is placed between two plates of ***different character***, having a ***different function***. In contrast, the metering plate of Applicants' claimed invention is placed between groups of plates having the ***same function*** (i.e., catalysis). Hsu neither discloses nor suggests placing a metering plate between groups of identical plates having the same function. Moreover, as set forth in the paragraphs above, the combination of Hsu and Ashmead fails to disclose every element of Applicants' independent claims. Ashmead adds nothing relevant to the metering plate that resolves the deficiency of Hsu, nor does the Examiner explicitly cite Ashmead in the instant rejection. Therefore, Hsu's disclosure of a flow adjustment element does not render claims 2, 9 and 17 obvious.

With respect to claims 3, 10, 18, and 21, the Examiner states that Hsu discloses that any suitable design of flow adjustment element can be used to restrict the flow at a selected and determinable rate. Applicants substantially agree with the Examiner's reading of the relevant portion of Hsu. However, the subject claims recite an assembly having multiple metering plates, *each downstream metering plate having larger flow through holes than the metering plates upstream*. Hsu does not disclose or suggest the use of multiple metering plates of differing design, nor is there any suggestion in the reference that any benefit might accrue from varying the design of the metering plates across the axial length of the device. Ashmead adds nothing relevant to the metering plate that resolves the deficiency of Hsu, nor does the Examiner explicitly cite Ashmead in the instant rejection. In view of the discussion above, Applicants assert that claims 3, 10, 18 and 21 are not obvious over the disclosure of Hsu.

Regarding claims 4, 11, and 19, the Examiner states that Hsu discloses lateral flow of fuel through and between the plates, but does not include flow through holes that are axially offset. The Examiner relies upon Ashmead to supply the missing disclosure, stating that Ashmead discloses that axially offset holes result in the lateral

flow of material through a laminate reactor. The Examiner concludes that it would have been obvious to offset the flow-through holes of Hsu "as a matter of engineering design choice which is functionally equivalent to axially aligned flow-through holes, as known in the art and as demonstrated by Ashmead."

Applicants do not clearly understand the Examiner's argument, particularly the section quoted in the paragraph above. Contrary to the Examiner's assertion, Applicants teach that offset holes are not "functionally equivalent to axially aligned flow-through holes." The offset holes direct the fluid laterally along the surface of the plates, increasing the efficiency and utility of the device:

> [b]y offsetting the holes, the fluid is forced to impinge on the catalyst of each platelet before traversing 360 degrees sideways to exit through the next platelet holes where the process repeats. This continuous turning of the fluid promotes turbulence in the monopropellant and assures that the monopropellant makes continuous contact with the catalyst. *See*, page 9, lines 23-28

In contrast, axially aligned holes create an axial pipe-like structure through which the fluid moves axially, with minimal lateral flow onto the catalytic surface of the plates: Applicants disclose that the offset arrangement "preclude[s] pure axial flow" (page 9, line 23). As axially aligned and axially offset flow-through holes are functionally distinct, providing entirely different results, Applicants do not understand the assertion that the two distinct arrangements of flow-through holes are "functionally equivalent."

Regarding the disclosure of Ashmead, Applicants are unable to locate where in the cited section is found a disclosure of a plurality of plates with axially offset flow-through holes. Column 9, lines 47-65 discusses structures that are patterned onto the opposing faces of two contiguous plates, providing ***lateral*** flow of the fluid, not axial flow through. The Examiner refers to FIG. 4 and 5, however, Applicants cannot determine what portion of the cited figures the Examiner finds relevant. The cited

figures, in fact demonstrate that the Ashmead device uses axially aligned flow-through holes. *See*, for example, FIG. 4, 130V, 230V, 330V, 430V, and 530V; and FIG. 5, 120V, 220V, 50V, 550V, 650V, 750V, and 850V.

The subject claims explicitly recite that the flow-through holes of adjacent plates are axially offset. The claims are not drawn to a device in which some of the flow through holes on adjacent plates are axially aligned and some are offset. The Ashmead device includes a plurality of adjacent plates having their flow-through holes adjacently aligned. Thus, Applicants respectfully assert that Ashmead does not disclose or suggest a device in which the flow-through holes of ***each*** adjacent plate are axially offset.

With respect to claims 6 and 13, the Examiner states that both Hsu and Ashmead disclose circular plates. Applicants are substantially in agreement with the Examiner's interpretation of the references. Applicants assert, however, that the absence of elements from claims 1 and 8 upon which claims 6 and 13 depend, respectively, precludes a finding of obviousness of the subject claims.

Regarding claims 7 and 14, the Examiner concludes that both Hsu and Ashmead disclose that the plates are bonded in a monolithic stack. Applicants disagree that Hsu teaches a "monolithic" stack. Applicants use the term "monolithic" to refer to a bonded stack, distinguished from an unbonded stack (...can operate as a monolithic stack or as an unbonded stack." page 10, line 18). The Examiner references FIG. 1 and 3 of Hsu to support the assertion that Hsu teaches a monolithic stack. FIG. 1 and the text describing it are silent regarding the method of assembling the stack. FIG. 3 shows that the stack in assembled by means of a fastener (i.e., nut and bolt) running through the central axis of the plates. Such an arrangement is not bonded and, therefore, is not a "monolithic" stack as the term is used by the Applicants.

As discussed above, the references fail to disclose or suggest elements of independent claims 1 and 8, from which claims 7 and 14 depend. Therefore, Applicants respectfully assert that the rejected claims are not obvious over the cited references.

As the combination of references fails to disclose or suggest every element of Applicants' claimed invention, a proper *prima facie* case of obviousness cannot be set

forth over the combination of the cited references. Therefore, Applicants respectfully request the withdrawal of the rejection under 35 U.S.C. § 103(a) of claims 1-15, and 17-21 as being obvious over Hsu in view of Ashmead.

In addition to the failure of the combination of references to disclose or suggest every element of Applicants' claimed invention, Applicants submit that there is not motivation to combine the references: the proposed combination destroys the function and touted advantages of the device of Hsu.

2. The Suggested Modification Would Destroy the Object of Hsu

A suggested modification that renders the art unsatisfactory for its purpose is an improper basis for a *prima facie* case of obviousness. MPEP §2143.01. A stated object of Hsu is the provision of "a plate-type reformer in which the catalyst is in intimate thermal contact with thermally conducting plates" (column 3, lines 6-8). Contacting the catalyst with the thermally conducting plates provides for the elimination "or reduction of hot spots which would be detrimental to the catalysts or structure materials of the reformer" (column 3, lines 11-13). Hsu discloses a device that necessarily includes two distinct plate types, catalyst plates and thermally conductive plates. In contrast, Applicants' device is assembled entirely from a single type of plate, a catalyst plate. Thus, by definition, the catalyst of Applicants' device cannot be in intimate contact with a separate thermally conducting plate; there is no thermally conducting plate. Therefore, to arrive at Applicants' claimed device, the thermally conductive plates of Hsu would have to be eliminated, altering the function and principle of operation of Hsu and destroying one of its touted advantages. As such an alteration precludes any motivation to make the proposed modification, Applicants assert that the combination of references and the modification of Hsu necessary to produce Applicants' claimed invention is improper and cannot form the basis for a proper *prima facie* case of obviousness.

3. There is no Reasonable Expectation of Success

As discussed above, Hsu discloses that it is advantageous to include thermally conductive plates in contact with the catalyst in the disclosed devices. The presence of the separate thermally conductive plate prevents detrimental hot spots. In view of this teaching of Hsu, one of skill would not have the necessary reasonable expectation of success in producing a catalytic reactor of Applicants' claimed design, using only catalyst plates. One of skill would expect a device of Applicants' claimed design to be plagued by hot spots detrimental to both the catalyst and structural elements of the assembly.

The disclosure of Hsu would have precluded one of skill from concluding that they had a reasonable chance of success in producing a catalytic stack, which included only catalyst plates. As there was no reasonable expectation of success derivable from the combination of references, the combination is improper and cannot form the basis for a *prima facie* case of obviousness.

Over Hsu in view of Ashmead in view of Koga

Claims 5, 12, and 20 are rejected under 35 U.S.C. § 103(a) as being allegedly obvious over Hsu in view of Ashmead as applied to claims 1, 8 and 15, and further in view of Koga. The Examiner states that Koga teaches support columns on the plates.

As a threshold issue, Applicants do not claim a device with support columns, but rather a device with support columns that are formed by ***leaving selected portions of the plate unetched***. Koga does not disclose or suggest forming a support column by leaving a portion of the plate unetched, nor is such a disclosure or suggestion found in either Hsu or Ashmead. Therefore, a element of claims 5, 12, and 20 is not present in the art of record, and a proper *prima facie* case of obviousness cannot be set forth over the cited references.

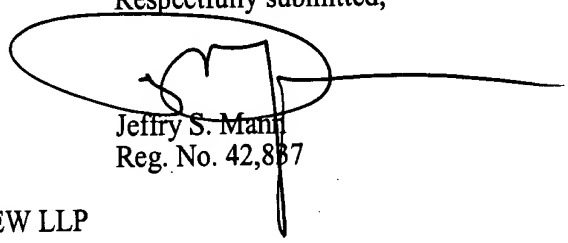
Moreover, as discussed in the sections above, the references fail to disclose or suggest elements of the independent claims from which claims 5, 12, and 20 depend. Furthermore, the proposed modification to Hsu is improper, and one of skill would have derived from the references no reasonable expectation of success. Therefore, Applicants submit that the rejected claims are not obvious over the cited references, and they respectfully request the withdrawal of the rejection of claims 5, 12, and 20 over Hsu in view of Ashmead and Koga.

CONCLUSION

In view of the foregoing, Applicants believe all claims now pending in this Application are in condition for allowance. The issuance of a formal Notice of Allowance at an early date is respectfully requested.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at 415-576-0200.

Respectfully submitted,



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VERSION WITH MARKINGS TO SHOW CHANGES MADE

15. (Amended) A catalyst bed comprising: a generally cylindrical array of catalyst material the axis of which is substantially parallel to the direction of flow of a fluid through said bed, the catalyst material being configured as the surface material of a plurality of stacked, contiguous, thin metal plates having axial flow-through holes of selected size and location to promote uniform flow and contact of said fluid with said catalyst material, at least a portion of each said thin metal plate on a downstream side is removed to provide a gap between adjacent plates to promote lateral flow of said fluid.

20. (Amended) The catalyst bed recited in claim 15 wherein said removed portion of each said plate comprises unremoved portions forming support columns for supporting each said plate on an adjacent said plate.

CLAIMS PENDING AFTER AMENDMENT

1. A catalyst bed for decomposition of monopropellant fuel using a transitional metal catalyst over which the fuel is made to flow; the bed comprising:

a plurality of thin metal plates in a stacked contiguous relation, each such plate having a surface of catalytic material and a plurality of flow-through holes of selected size and location for flow of said fuel axially through said stacked plates, at least a portion of each such plate on a downstream side being etched to permit lateral flow of said fuel between said plates.

2. The catalyst bed recited in claim 1 wherein said plurality of plates comprises a plurality of groups of said plates, each said group being separated from adjacent said groups by a metering plate having flow-through holes that provide reduced open area compared to the flow-through holes of said adjacent groups of said plates.

3. The catalyst bed recited in claim 2 wherein each said metering plate which is positioned more downstream of an upstream metering plate comprises larger flow-through holes than said upstream metering plate.

4. The catalyst bed recited in claim 1 wherein said flow-through holes of adjacent plates are axially offset from plate to plate to promote lateral flow of said fuel between said plates.

5. The catalyst bed recited in claim 1 wherein said etched downstream side of each said plate comprises unetched portions forming support columns for supporting each said plate on an adjacent said plate.

6. The catalyst bed recited in claim 1 wherein said metal plates are substantially circular.

7. The catalyst bed recited in claim 1 wherein said metal plates are bonded to one another to form a monolithic stack.

8. A catalyst converter for promoting the decomposition of a liquid fuel into a gas; the converter comprising:

a plurality of thin metal plates having a surface formed of a catalyst material and stacked axially along a flow path of said fuel from upstream to downstream; each said plate having a plurality of flow-through holes leading from its upstream surface to its downstream surface, the downstream surface of each said plate being at least partially removed to promote lateral flow of said fuel between each pair of adjacent plates.

9. The catalyst converter recited in claim 1 wherein said plurality of plates comprises a plurality of groups of said plates, each said group being separated from adjacent said groups by a metering plate having flow-through holes that provide reduced open area as compared to the flow-through holes of said adjacent groups of said plates.

10. The catalyst converter recited in claim 9 wherein each said metering plate which is positioned more downstream of an upstream metering plate, comprises larger flow-through holes than said upstream metering plate.

11. The catalyst converter recited in claim 8 wherein said flow-through holes of adjacent plates are axially offset from plate to plate to promote lateral flow of said fuel between said plates.

12. The catalyst converter recited in claim 8 wherein said etched downstream side of each said plate comprises unetched portions forming support columns for supporting each said plate on an adjacent said plate.

13. The catalyst converter recited in claim 8 wherein said metal plates are substantially circular.

14. The catalyst converter recited in claim 8 wherein said metal plates are bonded to one another to form a monolithic stack.

15. (Amended) A catalyst bed comprising: a generally cylindrical array of catalyst material the axis of which is substantially parallel to the direction of flow of a fluid through said bed, the catalyst material being configured as the surface material of a plurality of stacked, contiguous, thin metal plates having axial flow-through holes of selected size and location to promote uniform flow and contact of said fluid with said catalyst material, at least a portion of each said thin metal plate on a downstream side is removed to provide a gap between adjacent plates to promote lateral flow of said fluid.

16. Canceled.

17. The catalyst bed recited in claim 15 wherein said plates are segregated into a plurality of groups of said plates and wherein each said group is separated from an adjacent group by a metering plate having flow-through holes the total area of which is less than the total area of the flow-through holes in said plates of said groups.

18. The catalyst bed recited in claim 17 wherein each said metering plate which is positioned more downstream of an upstream metering plate comprises larger flow-through holes than said upstream metering plate.

19. The catalyst bed recited in claim 15 wherein said flow-through holes of adjacent plates are axially offset from plate to plate to promote lateral flow of said fuel between said plates.

20. (Amended) The catalyst bed recited in claim 15 wherein said removed portion of each said plate comprises unremoved portions forming support columns for supporting each said plate on an adjacent said plate.

21. The catalyst bed recited in claim 15 wherein each said plate is characterized by an open area ratio which is defined as the combined area of the flow-through holes divided by the total area of the plate and wherein the open area ratio of said plates generally increases along said direction of flow.